MAY 12 1910

JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

Entered as second-class matter May 7, 1906, at the Post Office at San Francisco, Cal., under the Act of Congress March 3, 1879

VOL. XXIV NO. 19 | SAN FRANCISCO, MAY 7, 1910 | PER COPY, 10 CENTS

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JOURNAL OF ELECTRICITY
POWER AND GAS
Devoted to the Conversion, Transmission and Distribution of Energy

VOLUME XXIV SAN FRANCISCO, MAY 7, 1910. NUMBER 19

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THE DEVELOPED HIGH-TENSION NET-WORK OF A GENERAL POWER SYSTEM[1]

BY PAUL M. DOWNING.

The greatest incentive to the development and construction of hydroelectric transmission systems has been high fuel costs. This is particularly true in California, where, until the discovery of oil a few years ago, practically every industry using steam as a motive power had to depend on coal imported from Australia or British Columbia.

Owing, however, to the natural advantages due to the topography of the country, the possibilities of utilizing the waters for hydroelectric development were early recognized, and probably more has been done along pioneer lines in this State than anywhere else.

In the preparation of a paper on this subject, therefore, I have confined myself entirely to conditions as they have developed and as they exist in California at the present time, and to the experiences in connection with the different transmission systems, which together form probably the greatest mileage of high-tension net-work to be found anywhere in the world.

On account of the rapidly growing demand for power, it was not possible to wait for results, which, under ordinary conditions could have been obtained from actual operation, but, under the circumstances, things have been done which very conclusively confirm a statement made by Mr. Charles F. Scott in his paper on "Electrical Power Transmission," read before the International Electric Congress held in St. Louis in 1904, wherein he states that problems of transmission are not problems that can be solved in the laboratory alone, but the apparatus must meet the precise conditions of operation and be judged by experience.

The 4427 ft. Span of the Pacific Gas & Electric Co. Across Carquinez Straits.

The first polyphase high-voltage transmission system in the world was the one from Mill Creek to Redlands, a distance of 16 miles. The original installation consisted of three 250-kw. three-phase generators delivering 2400 volts at their terminals, and seven 100-kw. transformers stepping up from 2400 volts to 11,000 volts at which potential power was transmitted to Redlands. The unqualified success of this undertaking almost from its very inception, gave a great impetus to the industry, and within a very few years other installations were made, each with its particular type of apparatus and character of construction.

The Colgate power house of the Pacific Gas & Electric Co. was really the nucleus of the present 60,000-volt net-work, in that it was the first to install

[1]Paper presented at the San Francisco meeting of the American Institute of Electrical Engineers, May 5, 1910.

Map of High-Tension Transmission Lines and Power Plants in Central California.

(4) Northern California Power Co.
(5) Oro Water, Light & Power Co.
(6) Pacific Gas & Electric Co.
(7) Great Western Power Co.
(9) Snow Mountain Water & Power Co.
(11) Sierra & San Francisco Power Co.

apparatus to operate at that voltage, and it was, at the time, the largest and most important hydroelectric station in this part of the State. The history of this plant is unique, in that the generators were installed, in operation, and overloaded, before the construction work on the building was completed.

The system of the Pacific Gas & Electric Co. as it stands today represents the consolidation of a number of smaller companies, each with a system peculiar to itself, and none of them designed with a view of ever tying in with any other system. As a result, almost every type of apparatus from the comparatively small, low-voltage, rotating-armature generators, to the larger, more modern, rotating-field, high-speed machines, is represented.

This company controls and operates eleven different hydroelectric generating stations, having an aggregate capacity of 64,270 kw., distributed as follows:

Power house	Capacity in kilowatts	Generator voltage
De Sabla	13,000	2300
Centerville	6,400	2300
Colgate	13,700	2300
Yuba	600	2300
Alta	2,000	500
Auburn	350	500
Newcastle	900	500
Folsom	3,250	800
Electra	20,000	22[illegible]
Deer Creek	5,000	
Nevada	1,200	5500

Ten of these have a common frequency of 60 cycles and run in parallel on a 60,000-volt net-work which is also supplied with additional power from four independent companies.

The Great Western Power Co. delivers 60,000 volts by stepping down from its main line voltage of 100,000; the Sierra and San Francisco Power Co., the Northern California Power Co., and the Snow Mountain Power Co., deliver current at 60,000 volts direct.

At times, the load carried by these four companies amounts to an aggregate of 41,500 kw. In addition to the foregoing, we have the following reserve steam and gas engine plants which operate in parallel with the transmission lines when occasion requires; viz., Oakland steam turbine station, San Jose steam station, and Martin gas engine station.

The total reserve capacity at these three stations amounts to 21,500 kw. In Martin station are located two 4,000-kw. frequency changers (from 60 to 25 cycles) which are operated from the transmission line. The 25-cycle side is run in parallel with the 25-cycle gas engine-driven units, and also with the 25-cycle steam-driven station of the United Railroads.

The entire mileage of lines represented by the different systems which are tied together, exclusive of those of 11,000 volts and under, amounts to 1,920 miles.

The voltages of the different lines making up the net-work are as follows:

150 miles of 100,000-volt line.
1,390 miles of 60,000-volt line.
380 miles of 20,000-volt line.

It will be noted that lines of 11,000 volts and under are not included in the above for the reason that these lower voltage lines are considered as distributing lines and not as transmission lines.

The paralleling of stations in this manner, regardless of the length of line between them, or the loads carried, has not developed any difficulties, but on the contrary, it has been found that it could be done much more readily than where the generators are paralleled in the same station; nor is it customary to do this paralleling at generating stations alone, or on the low-voltage side of sub-stations. As a matter of fact, it is done almost entirely on the 60,000-volt side, using transformers of relatively small capacity connected from line to ground for synchronizing purposes.

The governing and the division of load between the different stations furnishing power to a system of this kind is not as great a problem as it would at first appear. Each station, excepting one, takes its alloted portion of load and makes no attempt whatever to govern, unless the frequency varies beyond certain predetermined limits, the speed control being left entirely to a single station. All important power houses are equipped with governors, which, except in the case of the governing station, are set so that they will be sluggish in their action, and will not operate except on wide variations of speed. Those in the governing station should obviously be adjusted to regulate as closely as possible. The governing is not limited to any one particular station, but it can be done at any station having sufficient capacity to handle the fluctuations of load.

In order to operate as we do, with a large number of stations running together, we found it necessary to have a chief operator, or what we have seen fit to call a "load dispatcher," who, so far as the details of operation are concerned, is in absolute charge of the entire system. Water cannot be taken out of a ditch or flume, a power house superintendent or foreman cannot shut down a generator or change the load carried on the station, and a line crew cannot work on a line, without first having the approval of the load dispatcher's office. He is at all times in direct telephone communication with every part of the system, and in the event of trouble which might interrupt service, has absolute control of all matters in connection with the re-establishing of service. In his office there is a board showing diagramatically every generating station, transmission line and sub-station on the system, together with dummy switches representing every air and oil switch, and the exact position of these switches, that is, whether open or closed. In addition to the record as shown by the board, a complete log is kept of every detail in connection with troubles of any kind, loads carried by the different stations, and any other matters pertaining to operation.

Telephone circuits are run on all transmission lines, but these are not depended upon for anything more than local use, such as for linemen reporting on and off the line, etc. They do not give satisfactory service when used over long distances, and they become inoperative when there is trouble on the line and when they are most needed.

For communicating between important stations we have circuits leased from the telephone company, which run on its regular toll line leads, and being over entirely different routes are not affected to any extent by transmission troubles.

Method of Operation.

As stated above, the different stations are, for the greater part of the time, operated in parallel. There

are two distinct advantages in operating in this manner:

1. The regulation of voltage is much more readily accomplished.

2. The capacities of the different stations can be utilized to their fullest extent.

On the other hand, there is a distinct disadvantage, as trouble on any part of the system will, to a certain extent, affect the entire system.

The inductive drop on the long lines forming a net-work of this kind is obviously high, especially where the induction motor load is heavy, and the power factor correspondingly low. The synchronous motor load represents a very small percentage of the entire load, and there is little opportunity to over-excite the fields and use them as boosters. The wattless current, therefore, becomes quite a problem, and has to be taken care of either by distributing it among the different power houses, or by taking it entirely on a single station, which can be handled very readily by proper adjustment of generator fields.

From an operating standpoint, and in order to better guarantee continuity of service to the more important districts, a reserve steam plant is very essential, and in this respect the modern steam turbine serves the purpose admirably. By reason of the fact that it operates equally well at all loads it can be connected in parallel wtih the transmission line, and under normal conditions will carry a good portion of the wattless current. At the same time it acts as a stand-by, and in case of line trouble it can pick up the load on very short notice.

Troubles on the long lines forming net-works such as this do not always seriously affect the entire system, but show only as momentary drops in voltage. The station generators are connected directly to the line, without circuit-breaking devices of any kind, and power is never cut off the lines unless it is impossible to keep it on. Immediately on the slightest indication of line trouble, the system is separated, leaving different sections or districts supplied from different sources. If the trouble is far enough removed from the generating station it will not be very severe on account of the inductive and ohmic drop of the intervening lines, and generally the operators will have time to separate the sections without more than a temporary drop in voltage. If, however, the trouble is near a power house, that particular station will be thrown out of synchronism with the system, and even the machines in that station may be thrown out of synchronism with each other.

Connection.

The greater number of the lines feeding into the system are supplied with transformers delta connected on the low-tension side and star connected on the high-tension side, with the neutral grounded.

This arrangement has proved very satisfactory, and while it might be said that there is a disadvantage in using such a connection on account of the grounding of one wire throwing a short-circuit on the system, yet there is a question as to whether or not this is a real disadvantage.

If all lines could be run through sparsely settled districts, or where there would be little liability of damage to persons or property were a wire to come down, there would, doubtless, be some advantage in operating with a delta connection, but where lines are run along public highways and through more or less thickly settled districts, it seems almost necessary that there should be some very positive indication to show when a wire goes down.

Some objection has at different times been raised by the telegraph and telephone companies to a grounded neutral system, on account of the inductive influences due to current through the ground, at times when the load is unbalanced. Experience, however, has shown that this is not the real cause of the trouble, but that the troubles these companies have are the result of what might be called static unbalance, or high-frequency disturbances due to arcing grounds, or other causes which occur to a greater extent in an underground system than in one where the neutral is grounded, and therefore at zero potential. This statement is borne out by experiments that have been made on telephone circuits paralleling or carried upon the same poles as the transmission wires, where loads aggregating as high as 3,000 kw. have been transferred from three to two transformers of a bank, or vice versa, with practically no effect on the telephone service other than slight change in the tone of the line.

Our usual practice is, where one of three transformers in a bank at the generating end is out of service, to carry load up to the capacity of the other two, or should occasion demand, to overload the two, making them carry the normal load of the three. It is not necessary to limit the unbalancing of power delivered to the line in this manner, and we would have no more hesitation in cutting out one of a bank of three 1500-kw. transformers than in cutting out one from a bank of three 100-kw. transformers. This same condition obtains in the case of step-down transformers. When the load to be supplied is small, and where the expense of installing three, or even two, transformers to give a three-phase distribution would not be justified it is customary to install a single transformer, connecting it from the line wire to ground. Installations of this kind ordinarily give no trouble whatever, but work as satisfactorily as though a bank of three were installed. Careful attention must always be given to the ground connection. These are made by connecting to the water mains, and also to ground plates buried to a depth depending on the character of the soil.

Occasionally it has been found where only a single transformer is used, that a severe static stress occurs on the low-tension side, which is severe enough to puncture the insulation of the lower voltage transformers supplied from the main transformer. These instances, however, have been comparatively few, and while it is something which might be expected from a connection of this kind, it very seldom occurs, and it has never been serious enough to make it necessary to abandon the practice.

The connection on the low-tension side of the step-down transformers is either delta or Y, depending entirely on the particular voltage condition to be met. Where the Y connection is used, the neutral is grounded in the same manner as on the high-tension side, and to the same ground wire.

So far as the actual operation of the system is

concerned, there is no preference as to the connection on the low side, but for economic reasons the greater number of low-tension distributing systems are supplied from the Y-connected transformer. We have never yet had any troubles which we could trace back and find to be the result of the manner in which transformers were connected.

Transformers.

The capacities of transformers used, range from 100 to 1500 kw. Most of them, except some of the smaller sizes, are shell type, oil-insulated, and water-cooled. The most satisfactory case for oil-cooled transformers is one of boiler iron mounted on a cast iron base and having a cast iron top.

A great deal of discussion has been heard concerning the merits of the different insulating materials used in transformers for high-voltage work, the kind of oil to be used, and the methods of cooling the oil. During the past few years the tendency of the transformer manufacturers has been toward the use of a press board or horn fibre for the insulating barriers between the coils, this material being used to replace the micanite used in the earlier transformers. This gives a transformer of lower first cost but one correspondingly less staunch and reliable.

The micanite insulation has two distinct advantages; first, it will not absorb moisture as readily as the pressboard or horn fibre; and second, being non-inflammable, it will localize trouble, and a burn-out in one coil, unless it be exceptionally bad, will not damage adjacent coils. Until a few years ago all of the transformers on the system had micanite insulation. They would be received from the factory, and without attempting to dry them out, they would be filled with oil and put into service. The oil was generally shipped in iron drums containing from 50 to 100 gallons, and when received, it would be put into the transformer without treatment of any kind, and even without being tested to see that it had the proper dielectric strength. The pressboard has superseded the micanite, and the methods of handling transformers have entirely changed. We now find it necessary to dry them out thoroughly even after they have been standing without oil for not more than ten days or two weeks. The oil also is being handled much more carefully than formerly, and separate samples taken from the different tanks in which it is shipped, must be tested. If the dielectric strength is found to fall below a certain standard, it is safe to assume that the low insulating qualities are due to moisture, which can be readily removed by heating to a temperature slightly above 212 degrees Fahr.

The pressboard or horn fibre will not only absorb moisture from the atmosphere, but it will, when in direct contact with water, absorb sufficient of it to allow the layers of fibre making up the sheet, to separate, thus rendering it worthless. This objection to its use might on first thought seem hardly worth considering, but in practice it is an important one. In handling transformers out of doors during stormy weather, or in the event of a damaged water coil allowing water to get into the winding, the pressboard would be damaged to such an extent that the transformer would have to be torn down and the barriers replaced.

As to the relative fire risks of air and oil-cooled transformers, I think that it is now generally conceded that the oil type with a properly designed case is the safer of the two.

The greatest danger from an oil-insulated transformer is from fire external to the transformer itself, which might damage the case and allow the oil to escape.

In a number of instances there have occurred fires which have heated the boiler iron cases to such an extent that the oil has been badly carbonized and the paint on the inside of the case burned entirely off without damage being done to the winding. After removing the damaged oil and cleaning the winding, the transformers have been refilled with new oil and immediately put back into service without trouble. In one particular instance which I have in mind, a fire occurred in a wooden switch gallery almost directly over a bank of 700-kw. transformers which at the time were not in service. Before water could be turned on the fire the transformers had become very hot, and when water was finally turned on, the cast iron tops had become so hot that the water coming in contact with them, damaged them beyond repair. The windings of the transformers were uninjured, and after being dried out were put back into service and are operating today.

From the viewpoint of the man who has to operate the transformer, particularly in connection with long high-voltage lines, I am inclined to question the advisability of attempting to sacrifice the reliability of the transformer in order to cut down the first cost. In the absence of any approved device or apparatus that can be relied upon to take care of high-voltage line disturbances, the transformer must bear this burden to a very great extent, and the breaking down of a transformer with the resulting interruption to service, will, in a very short time, more than offset any saving in first cost. For this same reason the three-phase transformer is at a disadvantage, as trouble on one phase would entirely interrupt service, unless a spare were installed.

For cooling the oil we employ the usual method of circulating water through copper coils immersed in oil. Different metals have been used in these coils, but on account of there being less liability of copper being acted upon by acids in the cooling water, and also because of the fact that it will not corrode, it has been found most satisfactory. In localities where there is any great amount of mineral in the water, a cooling coil will in time become filled to such an extent that it will not carry a sufficient amount of water to cool the transformer. This deposit closely resembles boiler scale, and in some instances it can be removed by taking the coil out of the case and hammering it on the outside to loosen the scale, after which it can be blown out by either steam or compressed air. In cases where it cannot be removed in this way, we have used dilute muriatic acid as a last resort, but as this acts upon the metal of the coil, as well as upon the scale, it cannot be considered entirely satisfactory.

Periodic pressure tests are made on all cooling coils without removing them from the transformers, and very often without taking voltage off the transformer. This we do by disconnecting both ends of the

coil and allowing the water in the lower turns to either drain off; or, if both ends of the coil come up over the case, a small rubber hose is inserted on the riser side of the coil and the water syphoned out. To know that the coil is thoroughly dry, and that in the event of its breaking down under pressure, no water will get into the transformer winding, a light blast of air is passed through the coil, which, with the heat from the oil on the outside of the coil, will in a very short time remove any moisture which might remain. One end of the coil is then plugged and air pressure applied by means of an ordinary automobile tire pump. A small pressure gauge connected to the coil shows the pressure on the

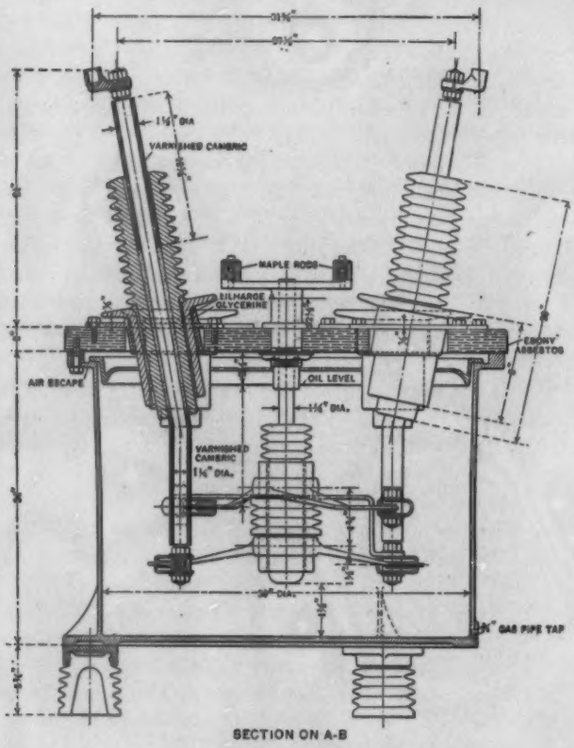


Fig. 1. Elevation of High-Tension Switch.

coil ,and also whether or not there are any leaks which would allow the pressure to drop. Generally where there is no back pressure on the coils, 15 to 25 lbs. will be as high a test as is necessary.

Switches.

Outside of the lightning arrester or line discharger for taking care of high voltages, high-tension switches were probably slower to develop than any other piece of apparatus used in connection with long transmission lines. It is only during the past few years that there have been any high-tension switches on the market, but there are now a number of different designs, all of which have proved generally satisfactory.

The system of the Pacific Gas & Electric Co. was one of the first to use oil switches for voltages in excess of 40,000. As early as 1900 we built and put into operation, switches which were of practically the same type that we are now using. While the switch was in the experimental stages, the framework supporting the tanks were of wood, and the tanks themselves were the ordinary fibre or paper mache tubs such as are used for laundry purposes. Switches of this kind served their purpose well, and are even now in use after years of service, but where they are called upon to break heavy loads, such as come on at times of short-circuit, they are apt to throw the oil out of the container when operated.

To overcome this trouble, we designed a four-break switch, along practically the same lines, but with a considerably greater depth of oil over the contacts. Four-break switches similar to the one shown in Figs. 1 and 2, have been in service in some of our largest power houses for several years, and they have never failed to open the line under all conditions of short-circuit.

The particular features which recommend this switch are:

1. The absence of any insulating material that might become saturated with oil and catch fire either from leakage or from an arc.

2. The insulation of the switch from the ground, thereby affording the greatest protection against break-downs due to surges or other high-voltage disturbances

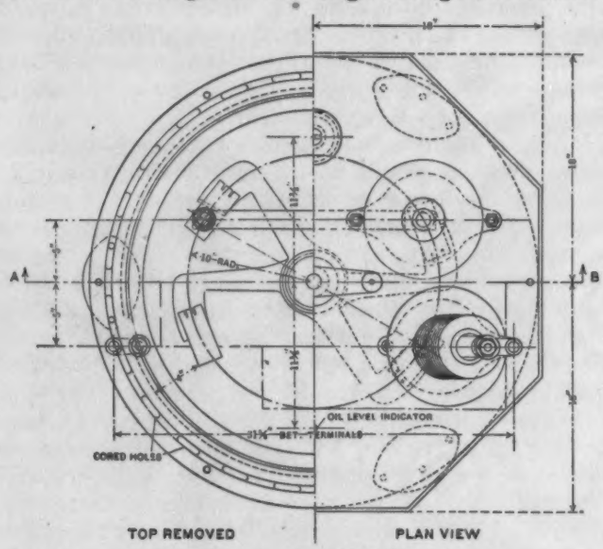


Fig. 2. Plan of High-Tension Switch.

when the switch is open.

3. A constant depth of oil over the contacts at all positions of the blades.

4. The comparatively small amount of space taken up by the switch.

We have never attempted to operate any of these high-tension switches either automatically or by any electric or pneumatic means, preferring rather to keep to the more positive hand-lever control. This control has generally proven quite satisfactory, but we have just installed some reverse current relays to be used in connection with the automatic operation of switches on lines which are tied together at both ends. We have yet to learn to just what extent these can be successfully employed, on account of the inherent weakness of alternating-current reverse-current relays, whose operation is dependent on both current and voltage, and the fact that in cases of severe trouble the voltage may drop so low that the relay will be inoperative.

Lightning Arresters.

Except in the higher mountain districts the Pacific Coast is comparatively free from lightning, and we

make no attempt whatever to protect against lightning disturbances.

On most of the early installations, lightning arrester apparatus, such as was on the market at the time, was installed at different points along the line. Practically every type of multigap arrester was tried, all of which proved to be a menace rather than a protection on account of their arcing over whenever there was a heavy line disturbance. The result has been that long since they have been abandoned, and we now use only the horn-gap type arresters with the air-gap set so that they will arc across on voltages approximately 25 per cent above normal. The particular design of arrester used, consists of two gaps in series with the ground side, connected directly to earth without resistance.

These are used more on account of their being voltage limiting devices than on account of their being a protection against high voltages. Discharges over these arresters always cause a drop in voltage, and very often a momentary interruption to service until the arc breaks. We do not install them at every station, but only at the power houses and more important stations where heavy switching is done. The electrolytic arrester now on the market has been installed on some of the lines in this State, but as they have been in service only a short time, little can as yet be said concerning their efficiency or effectiveness.

Insulators.

The question of line insulation for the high voltages now being used on transmission lines, is the most serious problem engineers have to face, and while it is true that both the design and quality of the insulators manufactured today are far superior to those of a few years ago, it is also true that the limiting voltage of a transmission system is governed by the insulators.

The climatic conditions of the greater part of the Pacific Coast are peculiar in that there are two seasons, one wet and one dry; and it may seem strange to say that the insulator trouble during the dry season, or just when the first rains start in, is as much as or more than there is during the winter storms. The trouble is due to leakage over the surface of the insulator on account of the dirt and the salt which is deposited by the ocean fogs. As soon as the heavy rains come, this accumulation of dirt, etc., is washed off, and the number of insulator troubles is materially reduced. The number of insulators that actually puncture are very few, the greatest trouble being due to leakage. As a striking illustration of troubles of this kind, I might state that insulators operating successfully at 60,000 volts in the mountain districts outside of the fog belt, and where there is little or no dust, give a great deal of trouble on 11,000-volt lines in the bay district where they are exposed to more severe conditions of dust, fog and smoke.

Troubles of this kind generally affect insulators on grounded and ungrounded structures differently. If they are supported on poles where the leakage path to ground is a high resistance one, the top of the pole will be burned off, and generally the insulator is not damaged. But where metallic structures or grounded pins are used, thus giving a low-resistance leakage path to ground, the insulator is more often damaged by the arc, which very often is great enough to burn off the line wire.

Troubles of this kind naturally bring up the question of what design of insulator will best meet the conditions, and whether or not the theory that as much of the insulator as possible should be kept dry is a correct one. This theory has been carried out in the vertical or pin type insulator with the result that in the three and four-part insulators a good portion of the inner petticoat is protected from the rain and cannot be washed by the elements. It therefore becomes necessary to shut down the line and wipe them by hand. This cleaning is especially necessary in the fog district near the bay and along the coast, where it has to be done about twice each year. The suspension insulator has a decided advantage in this respect, in that a much greater part of the surface of the insulator is exposed to the rain and dirt, and is washed off during stormy weather. However, with the higher voltages at which this type of insulator is designed to be operated, there is every reason to think that similar troubles will be experienced, and doubtless the same homely means will sooner or later be resorted to in order to overcome it.

THE MEXICO LIGHT & POWER COMPANY'S ELECTRIC PLANT.

BY H. F. WEST.

The following interesting description of an electric plant in Mexico is reprinted from a recent issue of The Mining World of Chicago by the courtesy of whose editor the accompanying illustrations were supplied:

Necaxa is a well known name to all who dwell in the Federal District of Mexico and bordering States. Until a few years since it was noted as the site of one of Mexico's greatest water falls. Within the last 7 or 8 years it has carried especial interest as being one of the largest, if not the largest, generators of electrical energy in Mexico.

The Mexico Light & Power Co. has during these years been installing a plant, that, starting with modest proportions, has now assumed a stupendous scale. It is a Canadian enterprise, under the leadership of Dr. Pearson, closely allied to the interests which have recently concluded the San Paolo tramway and light plant in Brazil.

Practically the identical engineering staff, which successfully carried out the Brazilian enterprise, is now engaged on the construction of the Necaxa plant.

Power for the last four years has been furnished to Mexico City, operating there the tramways, manufacturing mills, and municipal street and house lighting. From 10,000 to 12,000 hp. has been utilized at El Oro, 175 miles distant, for operating mining machinery, mills and for lighting. To large consumers the charge is $50 gold per hp. year. The mines of Pachuca will soon be able to utilize this cheap and constant source of energy.

Necaxa is 75 kilometers northeast of Mexico City, in the State of Puebla, bordering on Hidalgo, and about 60 miles distant from the sea, across the State of Veracruz. The Hidalgo railroad starting from the city delivers one at Carmen, where the narrow-gauge,

Shay-engine road of the power company starts. Here there is a commodious and orderly camp capable of well entertaining visitors.

The altitude at Carmen is 2191 meters. From Buenavista reservoir, altitude 2203 meters, capacity 14,000,000 cu. meters, the water passes through the Carmen canal, in place of the Necaxa river. At Carmen the water of the Coaciula river, 1½ meter-seconds, is picked up and passed over the Necaxa river bed by an inverted syphon. The combined flood-waters then flow through the canal and tunnel into the Laguna reservoir, altitude 2180 meters, capacity 45,000,000 cu. meters. At the present time, about 5 meter-seconds are drawn from the Laguna dam, and passed into the Necaxa river, losing considerable head, but utilizing the volume. The flood-water from the Laguna passes by a tunnel into the Los Reyes dam, altitude 2170 meters, capacity 28,000,000 cu. meters. The Los Reyes canal, already constructed, was intended to convey the water to power house No. 2, altitude 1409, thus utilizing the head, and passing the water on to the Necaxa dam. This scheme has temporarily been abandoned.

The Necaxa river, carrying the combined waters, now flows through the site of the Texcapa dam, altitude 1400 meters, capacity 18,000,000 cu. meters, thence into the Necaxa dam itself, altitude 1274 meters, capacity 45,000,000 meters. Flowing into the Necaxa reservoir, through a recently constructed tunnel, is the combined water of the Tenango and Nexapa reservoirs, with capacities of 25,000,000 and 20,000,000 cu. ft. respectively. With the completion of the extensive dam now being constructed, the former will have a storage of 45,000,000 cu. meters. A flow of 1½ meter-seconds is estimated to be conveyed through the Tenengo tunnel.

From the Necaxa reservoir the water is conveyed to the power house, altitude 895 meters above sea level. Thus, at a glance, is seen the present and proposed scheme of operations. A large drainage south of the Nexapa reservoir will be picked up by an extensive system of tunnels, considerably augmenting the water supply.

At the present time there are six 5000-kw. generators installed. Two of 10,000-kw. are being added. This will normally increase the output to 50,000 kw. In reality each 5000 generator can maintain 8000 kw. Within two years, on the completion of the present installation, an output of 200,000 kw. is anticipated. Should the larger watershed, with an area of 75 to 20 kilometers, or 1500 sq. kilometers, be harnessed up a total of 300,000 kw. is to be reasonably expected.

Now to revert to the detail, much of which is of surpassing interest. Carmen is connected with Necaxa with a railroad 30 kilometers in length. Originally this was laid out as a wagon road—then traction engines were tried, but were unsuccessful. Finally, the road was converted into a railroad, using Shay engines. It is a marvelous piece of road. So full of sharp turns and twists is it that, at times, one is at a loss to conjecture in what direction the engine is heading. The roadbed drops rapidly, and the dial of the aneroid quickly indicates a fall of some 3000 ft. The line crosses an old bridge, known as "Puente de Totolapa," and winds along the steep side of the Necaxa canyon in a charmingly picturesque manner.

Showing Front of Dam Rebuilt After Accident.

After four hours dropping down the Necaxa canyon, following the river the entire distance, the impressive reservoir of Necaxa opens out. The track runs along the strip of territory marked with white "mojoneras," showing the company's grant. Below are seen the meadows, detached villas, and ruins of churches, soon to be inundated with the encroaching flood—a veritable "Philae" of Mexico.

The available head being 2358 meters at Coacoyunance while the power house No. 1 has an elevation of 895 meters, affords a drop of 1463 meters. This shows the potentiality of the larger proposed installation.

The available head from the Necaxa reservoir, to the present power house, is 375 meters.

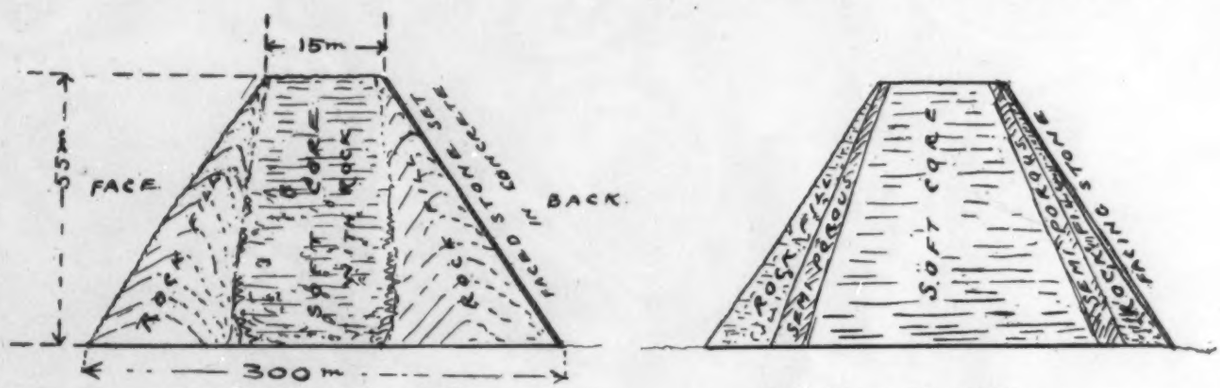
Another site, a few kilometers down stream, affords a fall of 300 meters, rendering possible practically double the output with a duplication of the present plant.

Back Wall—Riprap and Soft Central Core.

At the lower end of the reservoir is situated the Necaxa dam. This is quite notorious, and for more reasons than one. In the first place, it is an example—new to Mexico—of the modern method of dam construction. Then, again, owing to fortuitous circumstances, during the spring of 1909, a serious slide occurred, carrying out practically —the whole face of the dam. It will be of interest to briefly describe the construction.

The proportions are imposing, embracing 1,600,000 cu. meters. It has a base of 100 meters, 15 meters at the top, and 55 meters high.

The design may be described as a loose rubble wall, slope 1 in 3, carried up, with natural slope inside, at both back and front. In the center is sluiced clay. It has been found that the clay deposited from the water effectually fills the interstices of the loose rock, rendering it watertight. The escaping water, carrying but 3 per cent solids, passes into the reservoir, and is thus utilized. In dam construction, as elsewhere, the local conditions and the material are the determining factors to success. A scheme perfectly feasible in one place may prove a fiasco in another. It is possible that such a reasoning had something to do with the failure of this dam. At all events the design has been considerably amended, as may be seen from the sketches.



Amended Construction. Former Construction.

Necaxa Dam—Hydraulically Deposited.

With the solid rock face and back, and a substantial filling between of the present design, the Necaxa dam will never go out again.

Extensive hydraulic operations, on either side, sluice in through V section, armored flumes, both rock and dirt. Water issuing through 4, 5 or 6-in. nozzles, under 300-lb. pressure, has energy sufficient to tear down the solid limestone of the mountain side, when

loosened with powder. It is a sight full of interest to watch these giants playing about, seemingly operated as easily as a garden hose. The jet trundles the boulders over as readily as if they were of cork. The rebound of the water forms rockets of dazzling whiteness, bearing along the smaller rocks high off the ground. The rocks, both large and small, go humming down the flumes. At the lower end they are deposited and disposed of as required. The cost of such operations is stated to be $1 gold for every cubic meter the dam contains, and it may be double that figure if any mishap occurs. The company has no less than seven dams, either built, started or building. Four of these are each a formidable undertaking.

During December, 1909, the Necaxa dam held abou 7,000,000 cu. meters. It will hold 45,000,000. This means a rise of 60 ft., all but equaling the height of the operating tower seen in the illustration, and almost submerging the small island in the middle distance.

Situated amidst an amphitheater of surrounding hills, pine clad to the summit, the tawny flood reaching back from the solid stone work of the dam, engulfing hill and vale, Necaxa presents a striking picture; and to which, I fear, the camera does scant justice.

The site of Necaxa is interesting besides, by reason of its historical features. In 1856 the French auxiliaries marching to the relief of Maximilian made the "mesa de los flores" their camping ground, and there encountered the hostility of the Indians, by whom, in the rocky passes, they were considerably worsted. Cannon balls and war relics are reported found there to this day.

At the bottom of the canyon, close to the foot of the fall, is the power house. The installation consists of six 5000-kw. generators. The volume of water passed through in 24 hours is approximately 500,000 cu. meters. This corresponds to about 7 meter-seconds. During December about 200,000 cu. meters were being drawn from stock. Owing to the lack of storage occasioned by the accident to the Necaxa dam, the storage is below normal. This will not happen again after another wet season, owing to the vastly increased storage for the flood water. In December there were 35,000,000 cu. meters in storage; enough, it is anticipated, with the current supply, to bridge the interval against the normal wet season. A powerful steam plant of 13,000 hp. exists in Mexico City, to render assistance at any time should occasion arise.

To maintain one kilowatt-hour at Mexico City, bus-bars takes 1¼ cu. meters at Necaxa.

By the first of January, 1910, an addition of from 1 to 1½ meter-seconds was made to increase the supply through the Tenango tunnel.

When the reservoirs, at present completed and under construction, are filled with the surplus waters of the wet season, the storage will be around 155,000,000 cu. meters, sufficient, with the present consumption, to last 300 days. In addition to this is the constant flow, which will be increased from the tapping of the watershed to the south.

The power house is of solid construction, the machinery substantially erected, and the electrical equipment leaves little, if anything, to be desired. The generators are by the Siemens Schuekertswerte Co. It has been said there are six 5000-kw. generators, with two of 10,000 kw. being installed. Each generator is so liberally calculated regarding copper, that 8000 kw.

Hydraulicking Giant Playing Into Flume

Necaxa Power Station—Interior.

Showing Hydraulicking Flumes.

is readily maintained if desired. The daily load varies from 20,000 to 32,000 kw., probably averaging 24,000 for the 24 hours. Each generator is fixed to a vertical shaft, at the lower end of which is the impact wheel, 9 ft. in diameter. The weight is 36 tons. So efficient is the oil lubrication of the bearing supporting the shaft, that the rotor is easily moved by one finger. This film of oil is maintained under pressure, under ready regulation. The three-throw plunger pumps are regulated by an ingenious device, the speed of the rotor controlling the volume of the issuing jet, through regulation of the aperture of the nozzles. There are two nozzles, at opposite sides. The issuing jet has a velocity of 300 ft. per second. At present the water efficiency is 73 per cent. By the addition of 2 in. in depth to amended buckets, and by installing larger nozzles, the efficiency is expected to be 86 per cent. The output being increased 30 per cent, through increase of efficiency and volume. The orifice is rectangular, operated by powerful toggle-levers.

Although at work over three years, no perceptible wear is noticeable on the steel buckets, notwithstanding considerable sand is carried in the water.

The generators revolve at 500 r. p. m., generating 850 amperes at 4000 volts. This voltage is transformed to 60,000 and carried by three-phase line, No. 000 copper wire, on steel towers to Mexico City.

There are four transmission lines carried on two sets of towers. From the city two transmission lines, also on steel towers, convey the current 125 miles to El Oro, where approximately 12,000 hp. is constantly utilized. New coils are now at the power house to transform to 80,000 volts.

Two independent telephone lines are also strung on the towers, so that conversation with the city and El Oro is readily maintained.

The Necaxa power plant scheme started on comparatively a small scale, mainly the Necaxa reservoir and tributary waters. Then the larger scheme utilizing both pressure and volume from the Laguna dam was proposed, and afterwards discarded. The waters from the Tenango and Catapuxtla rivers were next made tributary by driving of the tunnel. Again other creeks were made tributary by the driving of other tunnels. At this stage 200,000 kw. are to be realized.

Finally the waters from the Coacoyuanca reservoir, 75 kilometers, from the proposed power house No. 3, were secured. From this latter scheme 300,000 kw. are anticipated. The figures embody the duplicating of the power house at the lower altitude. Thus is seen the scope of the present proposals.

The capital financing this enormous enterprise already amounts to $40,000,000, gold. There are employed 7000 operatives, including 100 foreigners. The basis of present and proposed operations cover 1500 sq. kilometers. Railroads connect all the principal points of construction, and ramify in all directions. There are four large dams in course of construction, each of which is a work of magnitude. The work in its entirety embraces at least eight dams. Truly Necaxa is an undertaking of colossal proportions.

The Mexico Light & Power Co. have their head office in Mexico City.

THE WATTHOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

CHAPTER VII.

(Continued.)

Testing and Adjusting.

To insure the continued accuracy of any watt hour meter it is necessary that it be tested and adjusted from time to time. In the smaller meters it is not necessary to make these tests oftener than about once a year, except in cases of complaint, and when meters are operating under adverse conditions; in the larger sizes, where a small variation in accuracy represents a considerable amount of money, the tests should of course be made oftener, especially where a meter of large capacity is called upon to register a small percentage of its rated load for a great part of the time. As a rule, the conditions under which the meter operates will dictate in a large measure the frequency of the tests.

The experience of the large number of distributing companies that have adopted some method of systematically testing and adjusting their meters has proven that the increased revenue resulting from more accurate meters has much more than offset the additional expense to which they have been put, besides reducing trouble and complaints due to occasional fast meters.

In testing meters which are in service it is much better to test and make any necessary adjustments at the point of installation, rather than to bring the meter into the testing room, since with the proper instruments the same accuracy can be obtained and a great saving in time can be effected. Such practice also avoids those injuries to the meter which are liable to occur in transportation to and from the customer's premises. Of course, where it is necessary to make repairs, it is best to bring the meter to the shop. That particular part of the meter which usually gives the most trouble and which requires the most frequent renewal is the jewel bearing. Jewels and pivots can be renewed at the point of installation without disturbing the meter. Friction in the jewel bearing will result in the meter running slow, and a new jewel should be substituted whenever a defective one is located. When installing a new jewel, a new pivot or ball should also be installed, as the old one is more than apt to have minute particles of the defective jewel imbedded in it, which will constitute an effective cutting tool and will soon ruin a new jewel. In the case of meters employing the ball and jewel bearing it is best to handle the ball with a pair of tweezers rather than with the fingers, as the moisture from the hands may cause the ball to rust.

There are several accurate methods used for testing watt hour meters, and the choice of the method or methods to be used is usually determined by the relative convenience of that method; the most common are (1) the voltmeter and ammeter method, (2) the indicating wattmeter method and (3) the portable rotating standard method.

(To be continued.)

TRANSMISSION LINE CROSSINGS OF RAILROAD RIGHTS OF WAY.

BY A. H. BABCOCK.

It is necessary to protect:

1. The railroad communication circuits (telegraph, telephone and signal) from mechanical injury and from contact with high tension wires.

2. The train crews from personal injuries due to sagging or fallen wires.

3. The trains themselves from mechanical damage and from the liability of fire should a wreck occur at the crossing point.

4. The railroad structures from damage by fire due either to crosses between communication circuits and fallen or sagging transmission circuits, or to high potential electro-motive forces induced therein by excessive unbalancing of the transmission circuits.

Having in mind the fact that contact with transmission circuits is dangerous to both life and property, it was natural that the early attempts at protection were of the nature of guard wires, in some form or other.

Many of us have had experience with some such device. Nearly all of us who have had sufficient experience have found unsatisfactory all forms of guards as yet devised. Even those of the deep basket type have failed at times to give complete protection. Furthermore, any pole line is worked at about minimum factor of safety; hence, to increase the load on it at the very point where maximum security is demanded is an engineering anomaly. Prophecy after the fact is easy.

The next step is obvious; to construct the transmission line with maximum factor of safety both in the crossing span and also in each of the adjacent spans, so that nothing short of a general catastrophe shall bring the line into dangerous proximity to the railroad right of way. So well recognized is this principle that the power and the railroad interests are now working in harmonious conjunction to devise an economical mechanical and electrical construction for these crossing spans, so much more secure than that of the transmission line elsewhere, that if ever failure occurs it must be at some other point.

In general, it is advisable, wherever possible, to place underground all low potential power circuits, and communication circuits. The following general specifications cover the points that are now under discussion between the power and railroad companies.

General Specifications for the Construction of Overhead Electric Light or Power Line Crossings.

General.

1. All crossings carrying current at more than nominal 2,300 volts to ground shall come under the provisions of these specifications, unless special conditions in large cities or otherwise shall make a modification thereof necessary or desirable.

2. Complete drawings shall be furnished in duplicate for approval before construction is commenced.

3. The power company shall give the railroad company one week's notice prior to the commencement of work.

4. All work, including the materials entering into the work, shall be subject to the inspection and approval of the railroad company.

5. The power company shall protect the railroad company against any suits for damages arising by reason of any patented devices being used in the work under these specifications.

Clearances.

6. Vertical clearance, under the most unfavorable conditions of temperature or sag, shall be as specified by the railroad company, but shall not be less than 35 feet above the top of rail and not less than 10 feet above any existing wires on the right of way.

7. Side clearance for structures that it may be necessary to locate on the railroad company's right of way shall not be less than 10 feet from the center of the nearest present or proposed track.

Crossing Span.

8. The crossing span shall be carried on towers or poles which shall be self-supporting under the most unfavorable conditions of loading, or of broken conductors.

9. Supports for the crossing span, and for the adjacent spans on each side, are to be generally in a straight line and preferably at right angles to the railroad.

10. Conductor supports shall be guyed away from the tracks in such manner as to make it impossible for the supporting structures to fall toward them.

11. In general, steel towers shall be used, although under certain conditions wooden structures, with concrete or other approved foundations, may be permitted.

12. Foundations shall be designed to resist double the greatest tendency to overturn under the most unfavorable conditions, due to breakage in the line or otherwise.

13. In designing tower foundations, the weight of earth shall be taken at 90 pounds per cubic foot and the weight of concrete at 140 pounds per cubic foot.

14. When towers are used, they shall be constructed of soft or medium soft steel, thoroughly painted or galvanized.

15. Tower construction shall be shown or specified in detail on plans submitted for approval by the railroad company. They shall give sufficient data so that stress diagrams may be constructed for the given loads.

16. All steel structures on the railroad company's right of way shall be grounded in an approved manner and shall be provided with approved danger signs.

17. Steel structures supporting the crossing span shall have a factor of safety of not less than three, based on the ultimate strength of the material and considered under the most unfavorable conditions of loading, wind and broken conductors.

18. Wooden structures supporting the crossing span, and also wooden crossarms, shall have a factor of safety of not less than five, based upon the ultimate strength of the material and considered under the

A paper to be presented at the San Francisco meeting of the American Institute of Electrical Engineers, May 5, 6, 7, 1910. Copyright 1910. By A. I. E. E. (Subject to final revision for the Transactions.)

most unfavorable conditions of loading, wind and broken conductors.

All the following sections shall apply to the crossing span and to each span adjacent thereto:

Pins.

19. Material: cast steel, malleable iron or other crude metal, galvanized.

20. Where wooden crossarms are used, a grounded metal strip must connect all pins electrically.

21. Pins shall be designed for factor of safety of three, under most unfavorable conditions.

Insulators.

22. Material: porcelain only above 7,000 volts, and porcelain or glass below 7,000 volts.

23. Insulators shall be designed for voltages 25 per cent in excess of the rated working voltage of the other insulators on the line.

24. Pin type insulators shall have metal bridge caps, or the equivalent.

25. If suspended type of insulator is used, all connections between the parts of he insulator shall be connections between the parts of the insulator shall be of the interconnected link type, or its equivalent. Whatever type of insulator and attachment is used, the conductor must hold to the supporting structure even if the insulator is mechanically or electrically shattered.

26. Clearance: Insulators shall clear all parts of the supporting structure (except pins and crossarms), not less than 12 inches up to 24,000 volts, plus one inch per 10,000 volts additional.

Conductors.

27. Material: copper, aluminum or other non-corrosive metal. For spans carrying current up to 5,000 volts, minimum size No. 6 B. & S. copper, or aluminum, or other material or alloy of equivalent strength. Above 5,000 volts, minimum size No. 0 B. & S. copper, not less than seven strands (or six strands around a non-conducting center), or aluminum, or other metal or alloy of equivalent strength.

28. Tension shall be adjusted to be equal on each side of the supports of the crossing span.

29. Clearance between conductors and tower structure (except pins and crossarms) shall be not less than 12 inches up to 24,000 volts, plus one-half inch for each additional 1,000 volts.

30. Minimum clearance between conductors shall be not less than 24 inches up to 24,000 volts, plus one inch per 1,000 volts additional.

31. The conductors shall be clamped mechanically to the insulator.

32. The conductors shall be connected to the supporting structure at an auxiliary connection that will insure positive grounding of the conductor in case of failure of the primary insulation.

33. All crossing conductors shall be wrapped or shielded against arcing where they pass over the insulators or through clamps.

34. No splicing will be allowed in any of the three spans named.

35. Crossings shall be designed for one-quarter inch ice radially of weight 60 pounds per cubic foot, plus the weight of the conductor, plus a horizontal wind pressure of 20 pounds per square foot on a projected area of the ice covered cable. (Obviously where ice is never formed, that element of the calculation can be omitted.)

36. Maximum of allowable stress shall be not more than three-tenths of ultimate strength.

37. All calculations shall be based upon a temperature range of 130 degrees Fahrenheit.

The foregoing specifications are tentative in the sense that while they represent the present mutual understanding of the interested parties, they have been adopted merely as a provisional basis for discussion. As such they are submitted for the consideration of the members. It is hoped that your criticism will be constructive as well as destructive.

The following table will serve to show that the subject is one not to be disposed of lightly. With 482 crossings to be legislated for on a single Trunk Line, it is easy to see that the agreement reached must be reasonable and equitable, or it will not stand.

Classification of Power Crossings.

Southern Pacific Company.

Division	Under 2500 V.	2500 to 5000 V.	5000 to 10000 V.	10000 to 15000 V.	15000 to 25000 V.	25000 to 35000 V.	35000 to 65000 V.	Over 65000	Not Listed	Total
Coast ...	119	3	30	13	8	0	5	0	1	179
Western..	47	3	9	7	3	3	42	3	3	120
Sacramento	42	6	6	0	14	0	12	5	..	85
Shasta ...	11	0	0	0	8	0	3	0	5	27
S. Joaquin	6	0	0	3	2	18	0	5	2	36
L. Angeles	1	0	0	0	18	6	0	0	2	27
Tucson ..	1	0	0	0	0	0	0	0	0	1
Salt Lake	1	0	1	2	0	0	2	0	1	7
Total ..	228	12	46	25	53	27	64	13	14	482

ELECTRICAL EQUIPMENT FOR METAL MINE.

To the Editor: I was much interested in the able paper, "Electrical Equipment for Metal Mine," by Mr. R. W. Shoemaker, which furnishes more practical facts than can be found in several volumes of books supposedly written by people who actually know, and no doubt this paper will prove of inestimable value to many engineers.

There are two points in the paper that I trust Mr. Shoemaker will make clear; what was the total head and number of gallons of water handled by the two Cameron pumps requiring a 300-horsepower compressor? and by the centrifugal pubp handling a 25-foot suction without trouble?

It has been the writer's experience and I believe that most centrifugal pump men agree that when the suction head exceeds 15 feet trouble can be looked for, and most makers recommend placing the pump as near the water as possible, for when pumping much above that head air will eventually work into the suction so as to cause the pump to lose priming. The difficulty of priming a centrifugal pump under a 25-foot suction head is a source of annoyance and difficulty.

It appears to me that an easier solution would be the use of direct connected vertical pumps when the pump could be submerged, requiring no priming and the motor set a good, safe distance above high water.

M. C. LORD.

JOURNAL OF ELECTRICITY
POWER AND GAS

PUBLISHED WEEKLY BY THE
Technical Publishing Company

E. B. STRONG, President
A. H. HALLORAN, Vice President and Managing Editor
C. L. CORY, Secretary.
DIRECTORS
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604 MISSION STREET, SAN FRANCISCO

EASTERN OFFICE, 150 NASSAU STREET, NEW YORK
C. N. MANFRED, Eastern Manager

TERMS OF SUBSCRIPTION

United States, Cuba and Mexico	per year,	$2.50
Dominion of Canada	"	3.50
Other Foreign Countries within the Postal Union	"	5.00
Single Copies, Current Month	each	.10
Single Copies, prior to Current Month	"	.25

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Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas." Weekly.

FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

The Developed High-Tension Network of a General Power System 427
By Paul M. Downing.
Mexico Light and Power Company's Electric Plant 433
By H. E. West.
The Watthour Meter 437
By Shepard and Jones.
Testing and Adjustment.
Transmission Line Crossings of Railroad Rights of Way.... 438
By A. H. Babcock.
Electrical Equipment for Metal Mines 439
By M. C. Lord.
Editorial 440
Institute Meeting.
Load Dispatching.
Personals 441
San Francisco Meeting of the A. I. E. E..... 441
Trade Notes 441
Industrial 442
Single-Phase Self-Starting Motors.
Electric Shovel.
Trade Catalogues 443
News Notes 444

Institute Meeting

San Francisco is now instructing and entertaining the country's electrical engineers gathered at the high tension meeting of the Institute. The Eastern visitors will take back with them some of the breadth of view which is inspired by a visit to this land of magnificent distances and by their contact with the men who are doing big things in annihilating these distances. We trust that they have but blazed the trail for the rest of their Eastern brothers who would also benefit by holding a national meeting of the Institute on the Pacific Coast.

Load Dispatching

Compare the four-horse chariot of the Roman, the ancient acme of power control, with the two hundred thousand and more horsepower controlled by the load dispatcher mentioned in P. M. Downing's paper this week. That one man should have such tremendous energy under his dominion surpasses the most extravagant conceptions of the Arabian Nights. Yet we have become so gradually accustomed to such wonders that it ceases to arouse more than passing comment.

The various power houses of the Pacific Gas & Electric Company generate over one hundred thousand horsepower, and connected to their transmission lines are other power companies, the Great Western, the Sierra & San Francisco, the Northern California and the Snow Mountain, with an aggregate installed capacity nearly as great. Most of this power is water-generated, steam and gas engines furnishing an auxiliary reserve.

The transmission lines tied together in these systems are nearly two thousand miles in length, the mileage of this combination network of high tension wires being greater than that of any other system in the world. The three hundred and fifty mile stretch from the Kilarc station of the Northern California Power Company in Shasta County to San Francisco is also the longest continuous transmission system in the world. As all of the generators in all these power houses are paralleled, or run in synchronism, the details of their control become of absorbing interest.

The heart of the system, to which all these arteries lead, is the office of the load dispatcher, who has even more responsibility than the chief dispatcher of a railroad. His telephonic approval governs every operation on the system and it is he that apportions the load to each power house and regulates the voltage. In case of accident or any interruption to service he must at once make such adjustments as will insure continuous power and light to the consumer. Every generating plant, transmission line and substation is shown in miniature on a board in this office, together with dummy switches which are set open or closed as may be the condition of the real switches they represent.

Experience has shown that the great size of the system facilitates voltage regulation, just as it is easier to maintain a given water level in a large lake than in a small pond. The inductance and resistance of the lines act as a cushion in case of line troubles, so that a local disturbance but slightly affects the rest of the system. Practically the entire regulation is left to one power house, having great enough capacity to handle all the load fluctuations. The large wattless current due to the inductive drop seems to be best handled by one station, preferably a steam turbine installation which is also available as a reserve.

Simple and obvious as these facts may appear on paper, they represent the patient solution of many vexed problems, requiring years in their unravelling and representing hard work for the pioneers in this great development.

PERSONALS.

W. M. Graham of the Los Angeles office of Holabird, Reynolds & Co. is in San Francisco.

C. R. Dederick of the C. R. Dederick Electric Supply Co. of Portland, Ore., is visiting San Francisco.

H. S. Graves, the new chief forester who recently succeeded Gifford Pinchot, is visiting the Pacific Coast.

H. J. Weigand is visiting San Francisco in the interests of the Cutler-Hammer Manufacturing Company of Milwaukee Wis.

W. S. Heger, Pacific Coast manager of the Allis-Chalmers Company, spent a part of the past week at his Los Angeles office.

T. B. Hunter, manager of the Monterey Water Company of Monterey, Cal. has been spending a few days in San Francisco.

Edward G. Dewald, of the hydraulic department of the Allis-Chalmers Company, is paying a visit to the Northwest Territory.

Leon M. Hall of Hall, Demarest & Co., engineers went to Virginia City the first of the week on business connected with the Comstock mines.

George H. Tontrup, general manager of the American Car Company of St. Louis, has gone to Portland on his way East, after visiting San Francisco.

J. W. Swaren, formerly of the Nevada Machinery and Supply Company, has been made sales manager of the G. W. Price Pump and Engine Company, of San Francisco.

A. H. Barrett, manager of the Louisville Gas and Electric Company of Louisville, Ky., who is making a tour of the Pacific Coast, spent the past week in San Francisco.

L. A. Somers of the Westinghouse Electric and Manufacturing Company's San Francisco sales department, has returned from a trip to Fresno and surrounding territory.

George R. Murphy, manager of the storage battery department of Pierson, Roeding & Co., of San Francisco, has returned from a business trip to Portland and the Northwest.

Beach Thompson, who promoted the Stanislaus Electric Power Company, which has been succeeded by the San Francisco Sierra Power Company, has returned from an Eastern tour.

W. W. Briggs, Pacific Coast district superintendent of the Westinghouse Electric and Manufacturing Company, with headquarters in San Francisco, contemplates leaving next week for a trip to Pittsburg and other Eastern cities.

W. J. Krase, who recently completed the installation of a turbine water wheel generating set for the Pelton Water Wheel Company in the new plant of the Utah Light and Railway Company at Gateway, Utah, is returning to San Francisco.

E. H. Le Tourneau, formerly inspector in the testing department of the New York Central and Hudson River Railroad Company, electric division, New York, has resigned to take charge of the power and electrical equipment of the Exchequer Gold Mining Company at Exchequer, Cal.

Among the Eastern electrical engineers attending the high tension meeting of the American Institute of Electrical Engineers in San Francisco this week were: L. B. Stillwell, president of the institute; Ralph W. Pope, secretary; G. I. Rhodes, engineer Interborough Rapid Transit Company, New York; W. F. Wells, general superintendent Edison Electric Illuminating Company of Brooklyn, N. Y.

A. I. E. E. SAN FRANCISCO MEETING.

Following is the daily program of the San Francisco meeting of the American Institute of Electrical Engineers:

Thursday, May 5th.

9:30 to 11 A. M.—Registration of members and visitors at headquarters in Home Telephone building.

11 A. M.—Paper by Mr. G. I. Rhodes on "Parallel Operation of Three-Phase Generators With Inter-Connected Neutrals."

2 P. M.—Paper by Mr. P. M. Downing, "The Developed High-Tension Network of a General Power System."

Friday, May 6th.

10 A. M.—Paper by Mr. J. J. Frank, "Observation of Harmonics in Current and Voltage Wave Shapes of Transformers."

2 P. M.—Paper by Mr. John Coffee Hays, "Hydroelectric Developments and Irrigation."

Paper by Mr. A. H. Babcock, "Transmission Line Crossings of Railroad Rights of Way."

Saturday, May 7th.

10 A. M.—Paper by Mr. A. M. Hunt, "Emergency Generating Stations for Service in Connection With Hydroelectric Transmission Plants Under Pacific Coast Conditions."

During the meetings the ladies of the party were entertained at various teas and trips to nearby points of interest.

TRADE NOTES.

Henry F. Lyon formerly with Baker & Hamilton, and more recently with the United Iron Works, has opened offices in the Monadnock building, San Francisco, as representative of E. Keeler Company, water tube boilers; The Buckeye Boiler Skimmer Company; Meitz & Weiss, oil engines; the Sims Company, feed water heaters; Clark Engine and Boiler Company; Monarch Soot Blower Company.

H. H. Humphrey, interested in the Central Oregon Power Company, the concern that has an option for the purchase of the Awbrey Falls power project on the Deschutes River, near this place, and contracted for the purchase of 1,000 acres adjoining Lawdlaw, has arrived here and stated that his company would begin immediate work on the power project. The plan is to put in a plant at the falls to develop about 25,000 hp. first, and later to increase the capacity.

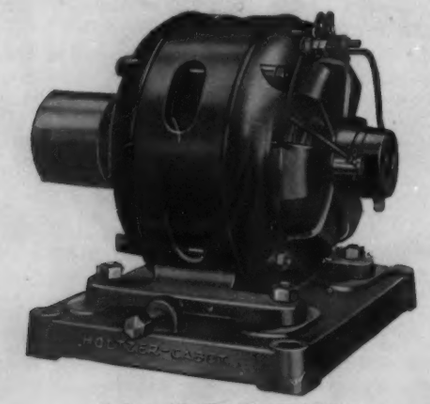
The Kleeb Lumber Company is building a new mill which is designed along the lines of the latest practice in this industry, and which will have electric motor drive throughout. Allis-Chalmers Company is furnishing the power equipment, which will include a 500-kw. 3,600 r.p.m., 60-cycle, 3-phase, 480-volt alternating current steam turbo generator, a surface condenser for maintaining the vacuum, a 15-kw., 120-volt motor generator exciter set, a three-panel switchboard with the necessary controlling apparatus and 22 induction motors ranging from 5 hp. to 200 hp. for driving the machinery about the mill.

A recent and one of the largest hydro-electric developments in California is the awarding of a contract to the Allis-Chalmers Company by the Northern California Power Company for the initial installation of machinery. The contracts calls for all the machinery and accessories and will include the following; Three 7,000 h.p. 450 r.p.m single horizontal turbines with cast iron spiral casings. The runners are 50 inches in diameter and the gate valves 42 inches in diameter. A size 2 oil pressure governor will control them. These trubines are each connected to a 5,000 k.v.a. 6,600 volt 60 cycle three-phase alternator. Excitation current will be supplied by either of two 220 kw. 120 volt generators direct connected to 350 h.p. 525 r.p.m. single impulse turbines controlled by type O governors. The turbines will operate under a head of 450 feet.

INDUSTRIAL

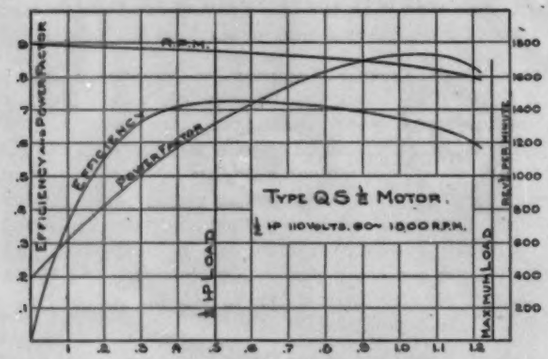
SINGLE-PHASE SELF-STARTING MOTORS.

The Holtzer-Cabot Electric Co. has recently placed on the market a line of single-phase, self-starting induction motors of the split phase type. These motors are characterized particularly by compactness, ruggedness and excellent starting and running properties. As these motors require only a double pole switch for controlling them, it is impossible to damage them by opening or closing the switch at any part of the starting cycle and they are particularly adapted to be controlled from a distance.



½-h.p. Single-Phase Motor.

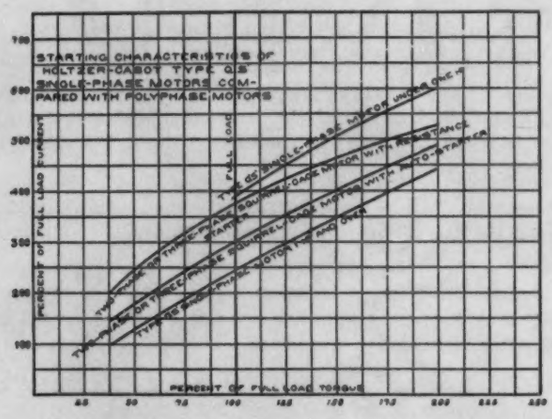
The compactness obtained in designing these motors enables them to be used in many places where there is not room for larger motors. The shafts and bearings, however, are unusually large. Every effort has been made to avoid complications likely to cause trouble. Mechanically the motors follow the type established by polyphase practice the world over. The rotors are of the simple "squirrel cage" type without any combustible insulation whatever, and are therefore practically indestructible. They are keyed solidly to the shaft. No friction clutch, commutator or revolving winding is necessary to enable the load to be started.



Characteristic Curves of ½-h.p. Motor.

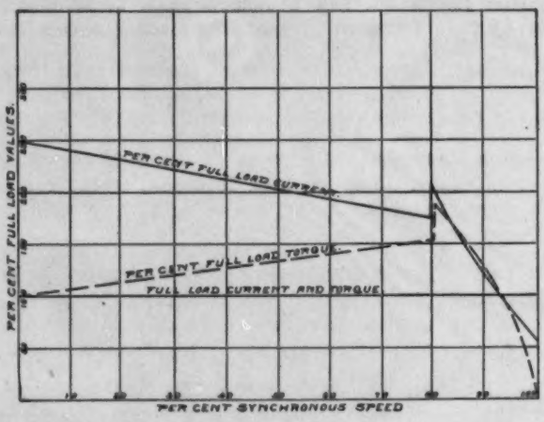
The electrical properties of these motors are particularly good for single-phase machines, as may be seen from the accompanying curves of a half-h.p. motor. The motors are excellently ventilated and the temperature rise under full load is very low. Standard motors will carry momentary loads of 100 to 200 per cent more than rated loads.

In spite of the simple construction, the starting torque and current compare favorable with standard poly-phase practice. Motors of less than 1-h.p will start considerably over loaded with four to five times the full load current. The larger sizes are equipped with a special phase-splitting device which reduces the current on standard motors to about two and one-half times the running current. With this current, the motors exert full load torque at a standstill. As the speed becomes greater, the current decreases but the torque increases about 50 per cent before the centrifugal switch operates. A tap is provided from the starting compensator by means of which two values of starting torque and current may be obtained.


STARTING CHARACTERISTICS OF HOLTZER-CABOT TYPE QS SINGLE-PHASE MOTORS COMPARED WITH POLYPHASE MOTORS
PERCENT OF FULL LOAD CURRENT
PERCENT OF FULL LOAD TORQUE

Comparative Starting Currents for Induction Motors.

In case less than full load is to be started, an ordinary resistance starter may be inserted in one of the circuits thereby cutting down the starting current by an amount proportional to the load.


PER CENT FULL LOAD VALUES
PER CENT FULL LOAD CURRENT
PER CENT FULL LOAD TORQUE
FULL LOAD CURRENT AND TORQUE
PER CENT SYNCHRONOUS SPEED

Speed—Torque—Current Curves.

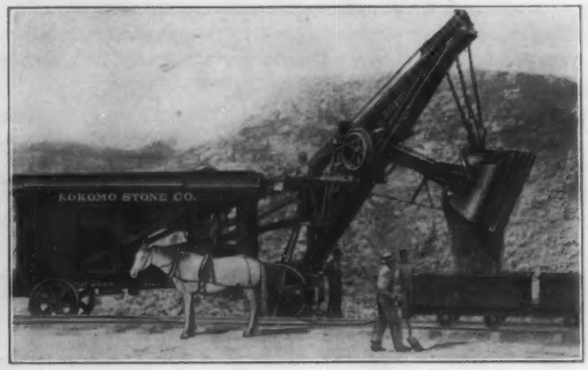
The fact that the starting torque increases with increased speed insures rapid acceleration. It also particularly fits these motors for the large number of cases in which the torque required increases at higher speeds.

TRADE NOTE.

The General Electric Company has sold to the Pacific Electric Railway Company of Los Angeles a 1,000 k.w. motor generator set rated as follows: A. T. I. 12-pole 1120 k.v.a. 500 r.p.m. 2,250 volt 60 cycle synchronous motor mounted on the same base and direct connected to a M. P. C. 8 pole 1,000 k.w. 600 volt generator. Also an exciter rated M. P. 6 pole 14 kw. 500 r.p.m 125 volt mounted on the motor end of the above set.

ELECTRIC SHOVEL.

Where electric power is available, an electric shovel offers many advantages over a steam shovel. Chief among these is the elimination of the boiler, the most annoying part of a steam shovel outfit. Very often the shovel works in territories where good water is not available, and as a result of the inferior feed water the boiler frequently requires repairs. Of course these repairs involve a loss of time and money. Besides, there are the expenses of a fireman, of piping or hauling water, and of hauling fuel, that go to make up a considerable outlay of money in the course of a year. Again, a steam shovel wastes considerable fuel and water at night, especially in winter, as the fire must be kept up to prevent the boiler and pipes from freezing. Furthermore, an important saving arises from the fact that an electric shovel uses power only when it is doing actual work. As, when steam power is used for a shovel, the steam must be kept up all the time, whether the shovel is at work or idle, there is a considerable waste of fuel and water. On an electric shovel, the power is always ready, easily applied, and is not being consumed when the shovel is idle waiting for cars or from any other cause. As soon as the power is cut off from the motors, the consumption of current stops; hence there is no wasts of current whatever.



Electric Shovel.

The electric shovel should appeal strongly to brick and tile manufacturers, to owners of stone quarries, cement plants, electric railroads, placer gold mines and ore mines that are being operated by what is known as the "open cut" method, as a battery of electric shovels operated from a central power plant will affect an enormous saving over steam shovels.

The shovel shown by the photograph is of the Little Giant type, mounted on cast steel traction wheels. It carries a 1¼ cubic-yard dipper and weighs approximately 35 tons. It will make a cut 40 ft. wide in a 10-foot bank and will clear a floor of 26 ft. The point of the crane stands 20 ft. above the ground. The dipper will dump 12 ft. 6 in. above the ground and 21 ft. out either way from the center of the shovel. The car body is 23 ft. long by 7 ft. wide.

The shovel is equipped by three Westinghouse motors as follows: One 60-h.p. motor for hoisting the dipper, one 30-h.p. motor for swinging the crane, and a 30-h.p. motor on the crane for crowding the dipper into the bank. All the motors are for 60-cycle, 2-phase, 220-volt alternating current. The shovel has a capacity of from 600 to 800 cubic yards of the blasted rock shown in the photograph per 10 hour day. It was installed for the Kokoma Stone Company, by the Vulcan Shovel Company, Toledo, Ohio.

NEW CATALOGUES.

Bulletin No. 122, from The Electric Storage Battery Company, illustrates and describes the installation of "Chloride Accumulators" and "Exide" batteries in yachts and power boats.

Bulletin 7A, from the Engineering Department of the National Electric Lamp Association, outlines the historical development of series incandescent lighting and furnishes data on the Mazda street series lamp and its equipment.

In Bulletin No. 4721, just issued by the General Electric Company, are illustrated and described to some extent the company's direct current watthour meters. Types C-6, C-7 and CQ. These meters are made for two- or three-wire service, 100 to 200, 200 to 240, and 500 to 600 volts.

Bulletin No. 5 from Benjamin Electric Manufacturing Company is devoted to Benjamin Mazda-Tungsten Fixtures and Accessories. These include representative requirements for in- and out-door service and corresponding ceiling and pendant fixtures for best utilizing Mazda tungsten lamps.

Bulletin No. 4720 recently issued by the General Electric Company describes in considerable detail the company's steam and air flow meters. The economical generation or consumption of steam, like that of electricity, gas and other commodities, depends on accurate information which will show the amount being generated, consumed or distributed. Equally important is the determination of the exact amount of air being delivered or consumed, where air is used in place of steam as a working agent. The recording and indicating steam and air flow meters described in this publication provide the means for obtaining such information. This bulletin should be of interest to all central station managers.

The Western Electric Company has recently issued its bulletin No. 5360, which takes up the subject of Hawthorn small power motors. The bulletin describes small motors, both alternating and direct current, ranging from 1/6 h.p. to 1/30 h.p., suitable for various purposes, such as buffing and grinding wheels, sewing machines, meat grinders and other household machines which require little power to operate. The direct current motors are built for operation on 110 and 220 volts at various speeds from 1100 to 3400 r.p.m. All of these types may be had with either shunt, series or compound windings. The alternating current small motors are built for 110 and 220 volts at 60, 45 and 25 cycles, single, two and three-phase, at the several synchronous speeds, in a full line of fractional horsepower ratings ranging up to ¼ h.p.

KELLOGG RETURN POSTAL.

Plain facts, what most people want to know about, are sometimes the hardest to find in telephone literature. The average catalogue is an array of glowing statements on what the apparatus will or may do under the most favorable conditions. The "reasons why" are often neglected. There is often too much theory and too little plain discussion of practical points in the work—the kind of questions the "man with the telephone" has to ask about. To further bring out the fact that Kelloog bulletins are practical, especially with reference to magneto telephone work, the Kellogg Company is issuing a return postal folder, entitled "We Can Show You." The operator's difficulties with "rubbering in," signaling central secretly, etc., are mentioned in the postal as being fully explained, with many other features of modern telephone practice, in the Kellogg bulletins, which will be sent promptly on request. The educational features of Kellogg Party Line Bulletin No. 30, written by Mr. H. N. Faris, Kansas City Branch, sales manager, a thoroughly practical telephone man, are well known and appreciated by both novice and veteran in the business. The demand for this bulletin has necessitated a second edition, which is now going to press.

NEWS NOTES

INCORPORATIONS.

REPUBLIC, WASH.—The North Washington Power Company has been incorporated for $200,000 by L. W. Anderson

TOLEDO, ORE.—The Lincoln County Telephone & Telegraph Company has been incorporated for $10,000 by W. K. Merrill.

PORTLAND, ORE.—The Hood River Light & Power Company has been incorporated by John D. Wilcox, Wirt Minor and Robert Smith, all of Portland.

SEATTLE, WASH.—The Alaska Power Company has been incorporated with a capital of $1,000,000 by John D. Atkinson, Central building; Joy T. Hutton and P. C. Stoess, Colman building.

SAN FRANCISCO, CAL.—The Thomas Gas Light & Power Company of California has been incorporated by R. Thomas, F. A. and W. J. Schmalle, J. Weirich and W. W. Hashhurst, with a capital stock of $50,000,000.

SAN FRANCISCO CAL.—The Marysville and Colusa branch of the Northern Electric Railway Company has been incorporated by C. H. Hannon, L. J. de Sabla, S. Lilienthal, C. E. Springer and H. W. Furlong, with a capital stock of $1,500,000.

SAN FRANCISCO, CAL.—The United Light and Power Company has been incorporated at $6,000,000 by Alfred Sutro, F. D. Madison of San Mateo, William T. Barnett of Berkeley, Edward T. Zook of San Rafael and Charles Sullivan of Verano.

SAN FRANCISCO, CAL.—The South Side Light & Power Company has been incorporated with a capital of $1,000,000 by James Fisher, Berkeley; Fred G. Cartwright and T. R. Sullivan, San Francisco; E. R. Hough, Kentfield, and C. N. Beal, San Francisco.

SAN DIEGO, CAL.—The San Diego Electric Fixture Company, with capital of $20,000, has been incorporated. The company will manufacture and sell electric fixtures. The directors are P. W. Dyment, Lottie P. Dyment, B. E. Powers, William Biard and others, all of this city.

PORT TOWNSEND, WASH.—Three streams in the Olympic mountains are to be harnessed for the development of water power for the generation of electricity and commercial purposes. They are the Quicono, Dungoness and Docewallips rivers, all within the boundaries of the Olympic forest reserve. A company has been incorporated under the name of the Olympic Power & Development Company, by W. B. Hartin, J. H. Carston and J. A. Calvett of Seattle, E. A. Sims of Port Townsend and E. W. Holander of Eberott, the capital stock being $250,000 Water sites have been located and the streams will develop between 25,000 and 30,000 horsepower at the lowest stages of the water.

FINANCIAL.

PLEASANTON, CAL.—Pleasanton's $40,000 sewer and water bond issue has been sold to the State of California, on its bid of par, $40 and accrued interest.

EL CENTRO, CAL.—Jas H. Adams & Co. have approved the $69,000 water bonds for a water system here and the bonds are now in the hands of the printers.

BAKER CITY, ORE.—A special election, called for the purpose of voting $200,000 in bonds for the repairs of a water system, resulted in a negative vote on the proposition.

LOS ANGELES, CAL.—A majority of 11,700 out of 13,000 votes was cast in favor of bonding the city for $6,500,000 to improve the harbor and develop 120,000 h.p. along the Owens River aqueduct.

PLEASANTON, CAL.—Pleasanton's $40,000 sewer and water bond issue has been sold to the State of California at a meeting of the Board of Trustees, the bid from that source having been accepted.

FALLON, NEV.—The City Council has introduced an ordinance providing for the issuing of waterworks bonds to the extent of $35,000. Another ordinance was introduced providing for the issuing of $10,000 bonds for the establishing of a sewer system.

SACRAMENTO, CAL.—The Mayor has returned with his approval a resolution declaring the necessity of a municipal filtration plant. Upon this resolution it is proposed to call another election to submit to the people the question of voting $666,000 in bonds to purchase the site and erect the plant.

EUGENE, ORE.—The Council has passed a resolution calling a special election for May 16th, for the purpose of voting on an amendment to the city charter, one authorizing the issuance of $150,000 in bonds for the purpose of refunding outstanding warrants, the other to authorize the issuance of $60,000 in bonds for extending the distributing system of the city waterworks and for a filteration system.

SEATTLE, WASH.—The Council has passed an ordinance authorizing the City Comptroller to advertise for the sale of bonds in the sum of $500,000, being a portion of the $1,080,000 bonds voted by the people at the election last March. The money is to be used for lining the Beacon Hill reservoir and Green Lake Low reservoir; for the cost of the water main in Spokane street and for the purchase of land at Taylor creek.

TRANSPORTATION.

MESA, ARIZ.—Dr. A. J. Chandler of Mesa has gone to Chicago, in the interest of the street railway for Mesa. They will probably build to Chandler's ranch, a distance of nine miles.

FRESNO, CAL.—The Fresno Traction Company has been awarded the Zapp's Park franchise, an extension of the street car system from Blackstone and Belmont avenues to the Kings river.

SAN BERNARDINO. CAL.—The Los Angeles County Electric Company, controlled by the Huntington interest, is to run electric lines between San Bernardino, Riverside, Redlands and Colton.

MILTON, ORE.—The Council has passed an ordinance granting to the Walla Walla Valley Electric Company a franchise to construct and operate an electric railway in certain streets in the city of Milton.

COALINGA, CAL.—The bid made by Judge W. H. Kerr, acting as a right of way agent has been accepted in exchange for the franchise for the proposed electric line connecting Coalinga with the outlying oil fields.

PHOENIX, ARIZ.—The Phoenix Railway Company is building a new car barn, fire-proof, 130 x 65, to replace the one burnt out in February, at which time they also lost six cars. They will probably put in twelve new cars this season, extending the line beyond Indian School for a distance of one and three-fourths miles. They are also extending the Washington-street line.

SAN FRANCISCO, CAL.—The public utilities committee has postponed action upon the application of Thomas W. Forsyth for a street railway franchise on Parnassus avenue, Judah street, Ninth avenue and Pacheco street, being an extension of about one mile of the Masonic avenue line, to allow residents along the proposed route to present written petitions in approval of the work.

SAN FRANCISCO, CAL.—Paul Shoup, assistant general manager of the Southern Pacific Company, in charge of its electric car lines in California, has accepted the deeds for the right of way for the electric line through Ravenswood. F. E. Chapin, manager of the Peninsular Railroad Company, states that work has begun on the construction of the road. At present the line will be extended as far as the Crow residence, a short distance this side of Cooley's Landing.

DILLON, MONT.—The directors of the Virginia City Southern Electric Railway consisting of L. H. Leber, New York City; W. A. Clark, A. J. Bennett, I. Elling and Geo. E. Gohn, have held a meeting in the office of Clark & Duncan. Mr. Leber was given the authority to sell the bond issue of $200,000 and will go to New York, where he proposes to sell it. He will be back in five weeks and begin work on the construction of the electric railroad connecting Virginia City and Alder, the contract for which has been awarded to him.

GLENDALE, CAL.—The Glendale-Eagle Rock Railway Company has applied for a franchise for an extension of its present line commencing at Glendale and Fourth street, thence northerly along the east side of Glendale avenue to the northern city limits. This company has also made application for a franchise from the north city limits along Glendale avenue to Oak street, where the avenue crosses the Salt Lake Company's Glendale branch line. From Oak street to Verdugo Park a private right of way has been deeded to the company.

TRANSMISSION.

DAYTON, WASH.—A corporation capitalized at $500,000, with this place as headquarters, is being contemplated by the owners of the Waitsburg, Dayton and Pomeroy electric power plants. The proposed power plant of the new organization will be on the Tucanon and will generate 2,500 h.p.

RUPERT, IDAHO—The Secretary of the Interior has awarded contract to the Standard Underground Cable Company of Pittsburg, Pa., for furnishing copper wire to be used in extending the electric transmission line to the towns of Rupert, Heyburn and Burley, on the Minideka irrigation project, Idaho, at $3,263.37.

MANTON, CAL.—The Northern California Power Company's new steam shovel has arrived in camp and will be moved to the Ripley Creek plant to work down the ditch. It is expected the shovel will finish 200 feet of the ditch per day. All tunnels for the Inskip power house have been completed and the plant will be started about June 15th. Perry Crawford has installed the machinery.

NEW YORK—N. W. Harris & Co. have purchased $2,000,000 Pacific Coast Power Company first mortgage 5 per cent bonds, due March 1, 1940. This company, in addition to owning water rights near Seattle and Tacoma, capable of developing 80,000 h.p., owns a large majority of the common stocks of the Seattle Electric Company and the Seattle-Tacoma Power Company, the present income being at the rate of over three and one-half times annual interest charges.

EL PASO, TEXAS—The El Paso Electric Railway have completed a three-mile extension to the race track in Juarez. They are preparing to build fireproof carbarns and will add ten new cars of the prepay type. Pierson & Company will build a sawmill near Nueva Casa Grande on the Mexican Northwestern Railway with a capacity of 800,000 feet in twenty hours, having a power plant of 3-1000 kw. turbines, 16 return tubular boilers, 150 hp. each, and individual motor driven throughout. The bids will be announced later. The Sante Fe at Albuquerque are installing a 150 k.w. Warren generator direct current to an Ideal engine. They are overhauling the switchboard and will install a 150-h.p. return tubular boiler. They expect to sink a deep well to secure water supply for power purposes.

ILLUMINATION.

SAN DIEGO, CAL.—Upon recommendation of the street superintendent, the Council has decided to install a low arm electric arc light at India and C streets.

ELLENSBURG, WASH.—The City Council has granted A. E. Wright of Olympia a 50-year franchise to sell gas for illuminating and fuel purposes in the city of Ellensburg.

TEMPE, ARIZ.—A bill authorizing Tempe to issue bonds for the amount of $30,000 for the purpose of installing a municipal lighting system in this city, has been introduced at Washington.

FRESNO, CAL.—The local branch of the Pacific Gas and Electric Company is planning to lay pipes before summer through the newly admitted Belmont Addition and in the Forthcamp District.

BEND, ORE.—Frank Robertson, head of the Bend Townsite Company, has returned from Portland and announces that Bend's water system is to be enlarged and electric lighting system to be installed.

PORTLAND, ORE.—After hanging fire for several months, a deal has been made whereby the Hood River Light and Power Company takes over the properties of the Hood River Electric Light, Water and Power Company, for $115,000.

GALLUP, N. M.—The Gallup Electric Light Company, according to G. E. Burgess manager, will completely overhaul the plant this season, putting in a new 150 k.w. three-phase generator direct connected to a new engine and new boilers.

SANTA BARBARA, CAL.—To light the grounds surrounding the Southern Pacific depot and the thoroughfare to the Potter Hotel, five large bronze lamps will be installed at short intervals along the tracks between the station and the hotel.

LOS ANGELES, CAL.—The City Council has passed an ordinance for the furnishing of electric current for a period beginning August 14, 1910 and ending June 30, 1912, and furnishing tungsten lamps and necessary appliances for lighting the ornamental cast iron lighting posts located on Fourth from Main to Hill streets.

LOS ANGELES, CAL.—The Los Angeles Gas & Electric Corporation have recently purchased from the C. H. Wheeler Manufacturing Co. a 16,000 sq. ft. Dry Tube Surface Condenser, one of the C. H. Wheeler Co.'s new Rotrex Patented Vacuum Pumps and a 250 hp. DeLeval Turbine Driven Circulating Pump. The equipment is guaranteed to produce a vacuum of 28 inches when operating in connection with a cooling tower.

OAKLAND, CAL.—Permission has been granted the Central Oakland Light and Power Company, the company which has entered the local field in opposition to the Oakland Gas, Light and Heat Company, to excavate along Alice street between First and Second streets, for the purpose of connecting its present underground electrical system to the power house feeders. The work of laying its system underground is being taken up with rapidity by the new company. It has honeycombed all of the streets of the principal business district, and will soon be distributing electricity for lighting and power purposes.

SAN LUIS OBISPO, CAL.—C. F. Hoffman has presented an application to the Board of Supervisors for a franchise, for a term of 50 years, to lay gas pipes for the purpose of carrying gas for heat, light and power, to erect poles and wires for transmitting electric heat and power, along, under and upon public streets in the judicial township of San Miguel.

SAN FRANCISCO, CAL.—The 85-cent gas rate and the present legal charges for electric light have been renewed by the Supervisors in a bill unanimously passed to print. The action was without discussion or disagreement and on the recommendation of the artificial lights committee. Its final enactment by the board will make effective from July 1st the 85-cent rate, unless the lighting company secures a new injunction from the Federal Court similar to that under which a $1 rate is being collected. The electric light charge is 90 cents per 1,000 watthours, with reductions scaling from 5 to 40 per cent for monthly consumptions amounting to from 2000, 3000 to 9000 watthours.

OAKLAND, CAL.—City Electrician George R. Babcock has begun work in the drawing up of tentative plans and specifications for an extensive gas lighting system, to be installed in lieu of the present arc light system. Babcock is of the opinion that he can install a system of gas lighting on the city's streets which would afford practically twice the amount of light now secured at a cost but slightly in excess of that expended in the maintenance of the present arcs. The city electrician will plan for the maintenance of 12 gas lamps where one arc light is now maintained. These lights are to be placed about 100 feet apart, at a height of between 12 and 15 feet from the ground. In this way, the entire street and sidewalks would be lighted, which is not accomplished through the use of arc lights.

WATERWORKS.

LOS ANGELES, CAL.—A franchise was sold to Puente City Water Company for a pipe line in country roads around the town of Puente.

WALLA WALLA, WASH.—A petition for the construction of a water main on Roosevelt street has been adopted, the improvement to cost $700.

SONOMA, CAL.—L. L. Lewis awarded the contract for the laying of the pipe line from his property west of town to the Pacific Tank and Pipe Company, of San Francisco.

CHIHUAHUA, MEX.—The Department of Fomento has just granted a concession to M. Tamborrel, owner of the Penon Blanco ranch, on the Conchos River, to utilize the waters of the river, both for irrigation and motive power.

WINNEMUCCA, NEV.—The Winnemucca Water and Light Company has purchased the title in the J. N. Thomas and William Nelson ranches in Grass Valley, and a pipe line is to be laid to the head of what is known as Thomas Canyon.

LOS ANGELES, CAL.—Accompanying a petition recently filed with the Supervisors, asking for a franchise to lay water pipes on California street and other streets, in Sunny Slope estate, was a check for $1,000 from the Cribb-Bodek Light and Water Company, to cover advertising expenses. It was ordered that bids be asked for grant.

SPOKANE, WASH.—The City Council disapproved the recommendation of the Board of Public Works that the construction of the two proposed standpipes be postponed until next year. The standpipes are in West Grove and Altomont. The board reported that through an oversight, no provision had been made to connect the new standpipes with heavy water mains and that the cost of doing so would be considerable.

LOS ANGELES, CAL.—Contracts for the construction of a water supply system for Orchard Dale have been let by Davidson Smith & Mizener. Weber & Dullen Company will manufacture and lay 18,000 ft. of 8 in. pipe and 10,000 ft. of 10 in. pipe, dig a trench for laying 6,000 ft. of 14 in. double riveted steel pipe between pumping plant and reservoir, and construct a concrete and corrugated engine house and pumping plant building. M. A. Singer, Whittier, will furnish 12 in. cement pipe.

ASTORIA, ORE.— The Commercial Club of Chino and the Push Club of North Beach are arranging to unite their efforts in securing a water supply for the two places. The feasible source of supply is Press Creek, about three miles from Chinook. The elevation of the proposed reservoir is sufficiently high to provide a gravity system with fire pressure at either town. To supply Long Beach from this point it will be necessary to construct a main eight miles in length and a right of way for the pipe line will be secured adjacent to the railway track.

TRINITY CENTER, CAL.—Seven thousand dollars are to be expended at once in rebuilding the electric power plant of the Trinity Water and Power Company, that was destroyed by fire last fall. The plant is needed to supply power to the Bonanza King mine, now to be resumed. Frank J. Symmes, new receiver for the California Safe Deposit and Trust Company, was authorized by Judge Seawell in San Francisco to make the expenditure. The power company and the mining company are corporations auxiliary to the Safe Deposit Company.

SAN FRANCISCO, CAL.—At the regular annual meeting of the stockholders of the Spring Valley Water Company the following directors were elected: F. B. Anderson, T. B. Berry, W. B. Bourn, A. Borel, S. P. Eastman, E. L. Eyre, C. Osgood Hooker, I. W. Hellman Jr., Homer S. King, E. J. McCutcheon, Louis F. Monteagle, A. H. Payson and J. M. Quay. The board of directors organized by electing W. B. Bourn president; A. H. Payson, vice-president; S. P. Eastman, second vice-president and manager; T. B. Berry, treasurer; J. E. Behan, secretary, and T. M. Edmunds, assistant secretary.

SAN FRANCISCO, CAL.—The Harbor Commissioners have fixed the monthly rental of the Spring Valley Water Company's hydrants on the water front at $250, dating from April 1st. The board had previously fixed the rate at $500 a month, but after a conference with the officials of the company made the reduction. Grain merchants submitted a petition to the board asking for the widening of the seawall grain sheds 80 to 100 feet, in order that deeper water might be provided for vessels docking there, and for the construction of a submerged railroad track on the seawall, for the more convenient handling of grain. Secretary Thorpe was directed to inform the petitioners that there is no money available for the suggested improvement, but that it may be soon forthcoming.

SAN FRANCISCO, CAL.—A contract for the cast-iron pipe specials, consisting of joints, crooks, curves, elbows, etc., to be used in the auxiliary water system for fire protection, has been awarded by the Board of Public Works to the Enterprise Foundry Company of San Francisco, its bid being $89,000. The specials are to be largely made to order, which will allow the department to commence work laying pipe within a few days. The first district to be served will be north of Market and east of Powell streets, work being initiated at several places at one time. It will be done by contract, for which bids will be asked. The contract was awarded to the Enterprise people, theirs being the only bid. Fifteen other foundry operators joined in a letter to the board, refusing to bid because the specifications as prepared made no provision for a strike clause.